Multiple Target Localisation at over 100 FPS

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Problem: Fast Localisation

Known Target

Camera Image

Localised Target
Local Feature Methods

- Interest Region Detection
- Region Matching
  - Descriptors: SIFT, MOPS, GLOH
  - Classifiers: Randomised Trees, Ferns
Quantised Patches

- Sparsely sampled 8 x 8 rectangular patch
- Quantised relative to $\mu$ and $\sigma$ of samples
Training Set

- Artificially warped views of entire target from different viewpoints
- Grouped into “viewpoint bins”

Scale Bin 4

Viewpoint Centre
“Reference Frame”
Warped Views

Scale Bin 8

Viewpoint Centre
Warped Views
Extracting Subfeatures

- FAST-9 Interest Points
- Orientation Estimation

Rotate Sampling Grid  Bilinear Sampling  Quantisation
Clustering Subfeatures

Known warp

Select most repeatable
Histogrammed Intensity Patches

- Histogram of intensity for each sample

... 1081 subfeatures in total
Binary Representation

- Histogram values quantised to 1-bit
- 40 bytes per feature model

00001 00001 11000 11110
Dissimilarity Score

- Count of pixels in “rare” bins for a feature

Matching Patch
00010 00010 00001 00001 ... - Patch
00001 00001 11000 11110 ... - HIP
00000 00000 00000 00000 ... - ANDed

Bitcount(ANDed) = 0+

Non-matching Patch
10000 10000 10000 10000 ... - Patch
00001 00001 11000 11110 ... - HIP
00000 00000 10000 10000 ... - ANDed

Bitcount(ANDed) = 2+
Binary Tree Lookup

- Exploits similarity between HIPs to avoid exhaustive search
Viewpoint Consistency

- Hough transform on target ID, scale, rotation
- Check vector between matches is reasonable
Comparison with Wagner et al. 2008

- Wagner et al. 2008 tested on 7 sequences
  - Total frame time around 5ms on average
  - Around 96% of frames localised successfully
Comparison with Wagner et al. 2008

- Over 4x faster
- More robust
- Memory usage 5-10 times lower
Multiple Target Localisation
Multiple Target Localisation

- Under 7.5ms with all 7 targets in database
- Small robustness penalty from
  - Additional matching targets
  - Indexing
Conclusions

• Classification-based matching can provide robust and fast localisation
• HIPs provide a memory and computationally efficient model for features
• Training phase can limit the impact of fast but inaccurate region detection approaches
• Tree-based lookup allows exact classification results without exhaustive comparison